19-1414; Rev 5; 10/07

Fault-Protected, High-Voltage Single 8-to-1/ Dual 4-to-1 Multiplexers with Output Clamps

MAX4508/MAX4509

General Description

The MAX4508/MAX4509 are 8-to-1 and dual 4-to-1 fault-protected multiplexers that are pin compatible with the industry-standard DG508/DG509. The MAX4508/MAX4509 operate with dual supplies of ±4.5V to ±20V or a single supply of +9V to +36V. These multiplexers feature fault-protected inputs, rail-to-rail signal handling capability, and overvoltage clamping at 150mV beyond the rails.

Both parts offer ±40V overvoltage protection with supplies off and ±25V protection with supplies on. On-resistance is 400Ω max and is matched between channels to 15Ω max. All digital inputs have TTL logic thresholds, ensuring both TTL and CMOS logic compatibility when using a single +12V supply or dual ±15V supplies.

Applications

Data-Acquisition Systems

Industrial and Process Control

Avionics

Signal Routing

Redundant/Backup Systems

Functional Diagrams/Truth Tables appear at end of data sheet.

Features

- **±40V Fault Protection with Power Off**
  ±25V Fault Protection with ±15V Supplies
- **Rail-to-Rail Signal Handling**
- **No Power-Supply Sequencing Required**
- **All Channels Off with Power Off**
- **Output Clamped to Appropriate Supply Voltage During Fault Condition**
- **1kΩ Output Clamp Resistance During Overvoltage**
- **400Ω max On-Resistance**
- **20ns Fault-Response Time**
- **±4.5V to ±20V Dual Supplies**
  +9V to +36V Single Supply
- **TTL/CMOS-Compatible Logic Inputs**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	PKG CODE
MAX4508CSE+	0°C to +70°C	16 Narrow SO	S16-8
MAX4508CPE+	0°C to +70°C	16 Plastic DIP	P16-4
MAX4508C/D	0°C to +70°C	Dice*	—
MAX4508ESE+	-40°C to +85°C	16 Narrow SO	S16-8
MAX4508EPE+	-40°C to +85°C	16 Plastic DIP	P16-4
MAX4508MJE	-40°C to +85°C	16 CERDIP**	J16-3

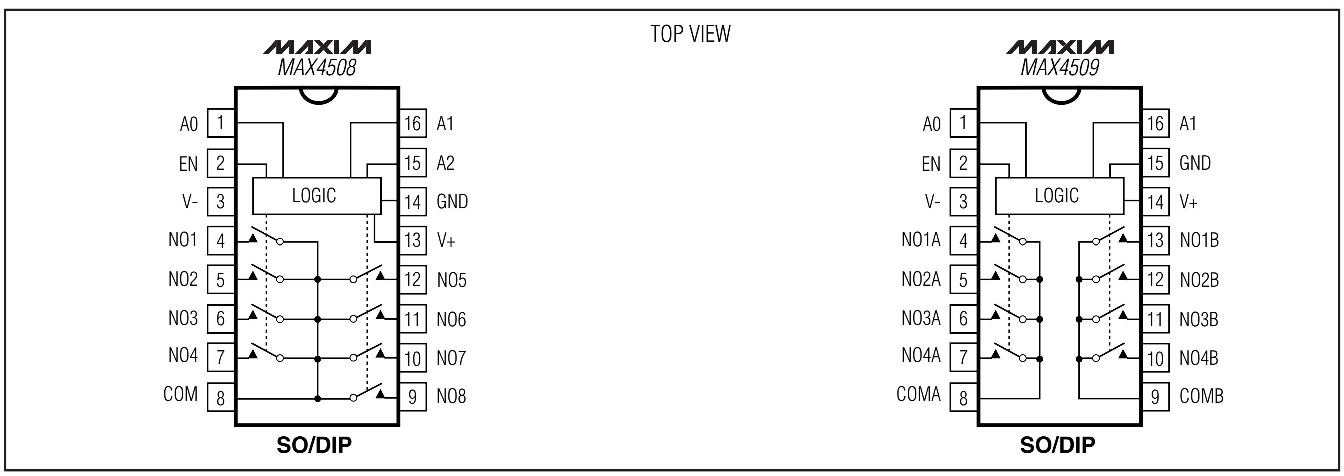
Ordering Information continued at end of data sheet.

**Contact factory for dice specifications.*

***Contact factory for availability.*

+Denotes a lead-free package.

Pin Configurations/Functional Diagrams



Fault-Protected, High-Voltage Single 8-to-1/ Dual 4-to-1 Multiplexers with Output Clamps

ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)
V+ ....-0.3V to +44.0V
V- ....-44.0V to +0.3V
V+ to V-...-0.3V to +44.0V
COM_, A_ (Note 1) .... (V+ + 0.3V) to (V- - 0.3V)
NO_...(V+ - 40V) to (V- + 40V)
NO_ to COM_ ....-36V to +36V
NO_ Overvoltage with Switch Power On. ....-30V to +30V
NO_ Overvoltage with Switch Power Off. ....-40V to +40V
Continuous Current into Any Terminal.............................±30mA
Peak Current, into Any Terminal
(pulsed at 1ms, 10% duty cycle)................................±100mA

Continuous Power Dissipation (T_A = +70°C)
16 Narrow SO (derate 8.70mW/°C above +70°C) 696mW
16-Pin PDIP (derate 10.53mW/°C above +70°C)..........842mW
16-Pin CERDIP (derate 10.00mW/°C above +70°C).....800mW
Operating Temperature Ranges
MAX4508C_ E/MAX4509C_E...............................0°C to +70°C
MAX4508E_ E/MAX4509E_E ....-40°C to +85°C
MAX4508MJE/MAX4509MJE..........................-55°C to +125°C
Storage Temperature Range ....-65°C to +160°C
Lead Temperature (soldering, 10s) ....+300°C

Note 1: COM_, EN, and A_ pins are not fault protected. Signals on COM_, EN, or A_ exceeding V+ or V- are clamped by internal diodes. Limit forward diode current to maximum current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—Dual Supplies

(V+ = +15V, V- = -15V, V_{A_H} =+2.4V, V_{A_L} = +0.8V, V_{EN} = +2.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		T_A	MIN	TYP	MAX	UNITS
ANALOG SWITCH								
Fault-Free Analog Signal Range (Notes 3, 4)	$V_{NO_}$	V+ = +15V, V- = -15V, $V_{NO_}$ = ±15V		C, E, M	V-		V+	V
On-Resistance	R_{ON}	$V_{COM_}$ = ±10V, $I_{NO_}$ = 0.2mA		+25°C		300	400	Ω
				C, E			500	
				M			700	
On-Resistance Match Between Channels (Note 5)	ΔR_{ON}	$V_{COM_}$ = ±10V, $I_{NO_}$ = 0.2mA		+25°C			15	Ω
				C, E			20	
				M			25	
NO_ Off-Leakage Current (Note 6)	$I_{NO_(OFF)}$	$V_{NO_}$ = ±10V, $V_{COM_}$ = ∓10V		+25°C	-0.5		+0.5	nA
				C, E	-5		+5	
				M	-50		+50	
COM_ Off-Leakage Current (Note 6)	$I_{COM_(OFF)}$	$V_{COM_}$ = ±10V, $V_{NO_}$ = ∓10V	MAX4508	+25°C	-2		+2	nA
				C, E	-20		+75	
				M	-200		+200	
			MAX4509	+25°C	-1		+1	
				C, E	-100		+75	
				M	-100		+100	
COM_ On-Leakage Current (Note 6)	$I_{COM_(ON)}$	$V_{COM_}$ = ±10V, $V_{NO_}$ = ±10V or floating	MAX4508	+25°C	-2		+2	nA
				C, E	-100		+75	
				M	-300		+300	
			MAX4509	+25°C	-1		+1	
				C, E	-15		+75	
				M	-150		+150	

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

($V+ = +15V$, $V- = -15V$, $V_{A_H} = +2.4V$, $V_{A_L} = +0.8V$, $V_{EN} = +2.4V$, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		TA	MIN	TYP	MAX	UNITS
FAULT PROTECTION								
Fault-Protected Analog Signal Range (Notes 3, 4)	$V_{NO_}$	Applies with power on, Figure 9		+25°C	-25		+25	V
		Applies with power off			-40		+40	
COM_ Output Leakage Current, Supplies On	$I_{COM_}$	$V_{NO_} = ±25V$, $V_{EN} = 0$		+25°C	-20		+20	nA
				C, E	-1		+1	µA
				M	-100		+100	
NO_ Input Leakage Current, Supplies On	$I_{NO_}$	$V_{NO_} = ±25V$, $V_{COM_} = ∓10V$, $V_{EN} = 0$		+25°C	-20		+20	nA
				C, E	-200		+200	
				M	-50		+50	µA
NO_ Input Leakage Current, Supplies Off	$I_{NO_}$	$V_{NO_} = ±40V$, $V_{COM} = 0$, $V+ = 0$, $V- = 0$		+25°C	-20		+20	nA
				C, E	-5		+5	µA
				M	-100		+100	
COM_ On Clamp Output Current, Supplies On	$I_{COM_}$	$V_{COM} = 0$	$V_{NO_} = +25V$	+25°C	7	10	13	mA
			$V_{NO_} = -25V$		-13	-11	-7	
COM_ On Clamp Output Resistance, Supplies On	$R_{COM_}$	$V_{NO_} = ±25V$		+25°C	100	1.0	2.5	kΩ
± Fault Output Clamp Turn-On Delay (Note 4)		$R_L = 10kΩ$, $V_{NO_} = ±25V$		+25°C		20		ns
± Fault Recovery Time (Note 4)		$R_L = 10kΩ$, $V_{NO_} = ±25V$		+25°C		2.5		µs
LOGIC INPUT								
A_ Input Logic Threshold High	V_{A_H}			C, E, M	2.4			V
A_ Input Logic Threshold Low	V_{A_L}			C, E, M			0.8	V
A_ Input Current Logic High or Low	I_{A_H}, I_{A_L}	$V_{A_} = 0.8V$ or $2.4V$		C, E, M	-1		+1	µA
SWITCH DYNAMIC CHARACTERISTICS								
Enable Turn-On Time	t_{ON}	$V_{NO_} = ±10V$, $R_L = 1kΩ$, Figures 2 and 3		+25°C		160	275	ns
				C, E			400	
				M			600	
Transition Time	t_{TRANS}	Figure 2		+25°C		170	350	ns
				C, E, M			500	
Enable Turn-Off Time	t_{OFF}	$V_{NO_} = ±10V$, $R_L = 1kΩ$, Figures 2 and 3		+25°C		120	200	ns
				C, E			250	
				M			400	
Break-Before-Make Time Delay (Note 4)	t_{BBM}	$V_{NO_} = ±10V$, $R_L = 1kΩ$, Figure 4		C, E, M	10	80		ns
Charge Injection (Note 4)	Q	$C_L = 1.0nF$, $V_{NO_} = 0$, $R_S = 0$, Figure 5		+25°C		2	10	pC
Off-Isolation (Note 7)	V_{ISO}	$R_L = 75Ω$, $C_L = 15pF$, $V_{NO_} = 1V_{RMS}$, f = 1MHz, Figure 6		+25°C		-70		dB

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

($V+ = +15V$, $V- = -15V$, $V_{A_H} = +2.4V$, $V_{A_L} = +0.8V$, $V_{EN} = +2.4V$, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		T_A	MIN	TYP	MAX	UNITS
Channel-to-Channel Crosstalk (Note 8)	V_{CT}	$R_L = 75\Omega$, $C_L = 15pF$, $V_{NO_} = 1V_{RMS}$, f = 1MHz, Figure 7		+25°C		-62		dB
NO_ Off-Capacitance	$C_{N_(OFF)}$	f = 1MHz, Figure 8		+25°C		10		pF
COM_ Off-Capacitance	$C_{COM_(OFF)}$	f = 1MHz, Figure 8	MAX4508	+25°C		19		pF
			MAX4509			14		
COM_ On-Capacitance	$C_{COM_(ON)}$	f = 1MHz, Figure 8	MAX4508	+25°C		28		pF
			MAX4509			22		
POWER SUPPLY								
Power-Supply Range	V+, V-			C, E, M	±4.5		±20	V
V+ Supply Current	I+	All $V_{A_} = 0$ or 5V, $V_{NO_} = 0$, $V_{EN} = 5V$		+25°C		370	500	µA
				C, E			750	
				M			850	
V- Supply Current	I-	All $V_{A_} = 0$ or 5V, $V_{NO_} = 0$, $V_{EN} = 5V$		+25°C		200	300	µA
				C, E			400	
				M			500	
GND Supply Current	I_{GND}	All $V_{A_} = 0$ or 5V, $V_{NO_} = 0$, $V_{EN} = 5V$		+25°C		200	300	µA
				C, E, M			500	

ELECTRICAL CHARACTERISTICS—Single +12V Supply

($V+ = +12V$, $V- = 0$, $V_{A_H} = +2.4V$, $V_{A_L} = +0.8V$, $V_{EN} = +2.4V$, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
ANALOG SWITCH							
Fault-Free Analog Signal Range (Note 3)	$V_{NO_}$	V+ = 12V, V- = 0, $V_{NO_} = 12V$	C, E, M	0		V+	V
On-Resistance	R_{ON}	$V_{COM_} = +10V$, $I_{NO_} = 200µA$	+25°C		650	950	Ω
			C, E			1100	
			M			1300	
On-Resistance Match Between Channels (Note 5)	ΔR_{ON}	$V_{COM_} = 10V$, $I_{NO_} = 200µA$	+25°C		10	35	Ω
			C, E			50	
			M			75	
NO_ Off-Leakage Current (Notes 6, 9)	$I_{NO_(OFF)}$	$V_{COM_} = 10V$, 1V; $V_{NO_} = 1V$, 10V	+25°C	-0.5	0.01	+0.5	nA
			C, E	-10		+10	
			M	-200		+200	

ELECTRICAL CHARACTERISTICS—Single +12V Supply (continued)

($V+ = +12V$, $V- = 0$, $V_{A_H} = +2.4V$, $V_{A_L} = +0.8V$, $V_{EN} = +2.4V$, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 2)

PARAMETER	SYMBOL	CONDITIONS		T_A	MIN	TYP	MAX	UNITS
COM_ Off-Leakage Current (Note 6)	$I_{COM_(OFF)}$	$V_{COM_}$ = 10V, 1V; $V_{NO_}$ = 1V, 10V	MAX4508	+25°C	-2		+2	nA
				C, E	-20		+75	
				M	-200		+200	
			MAX4509	+25°C	-1		+1	
				C, E	-10		+75	
				M	-100		+100	
COM_ On-Leakage Current (Note 6)	$I_{COM_(ON)}$	$V_{COM_}$ = 10V, 1V; $V_{NO_}$ = 10V, 1V, or floating	MAX4508	+25°C	-2		+2	nA
				C, E	-100		+75	
				M	-300		+300	
			MAX4509	+25°C	-1		+1	
				C, E	-15		+75	
				M	-150		+150	
FAULT PROTECTION								
Fault-Protected Analog Signal Range (Notes 3, 10)	$V_{NO_}$	Applies with all power on		+25°C	-25		+25	V
		Applies with all power off			-40		+40	
COM_ Output Leakage Current, Supply On (Notes 3, 10)	$I_{COM_}$	$V_{NO_}$ = ±25V, V+ = 12V		+25°C	-20		+20	nA
				C, E	-1		+1	µA
				M	-100		+100	
NO_ Input Leakage Current, Supply On (Notes 3, 10)	$I_{NO_}$	$V_{NO_}$ = ±25V, $V_{COM_}$ = 0, V+ = 12V		+25°C	-20		+20	nA
				C, E	-5		+5	µA
				M	-100		+100	
NO_ Input Leakage Current, Supply Off (Notes 3, 10)	$I_{NO_}$	$V_{NO_}$= ±40V, V+ = 0, V- = 0		+25°C	-20	0.1	+20	nA
				C, E	-5		+5	µA
				M	-100		+100	
COM_ ON Output Current, Supply On	$I_{COM_}$	$V_{NO_}$ = 25V, V+ = 12V		+25°C	2	3	5	mA
COM_ ON Output Resistance, Supply On	$R_{COM_}$	$V_{NO_}$ = 25V, V+ = 12V		+25°C		2.4	6	kΩ
LOGIC INPUT								
A_ Input Logic Threshold High	V_{IN_H}			C, E, M		1.8	2.4	V
A_ Input Logic Threshold Low	V_{IN_L}			C, E, M	0.8	1.8		V
A_ Input Current Logic High or Low	$I_{INH_}$, $I_{INL_}$	$V_{IN_}$= 0.8V or 2.4V		C, E, M	-1	0.03	+1	µA

ELECTRICAL CHARACTERISTICS—Single +12V Supply (continued)

($V+ = +12V$, $V- = 0$, $V_{A_H} = +2.4V$, $V_{A_L} = +0.8V$, $V_{EN} = +2.4V$, $T_A = T_{MIN}$ to T_{MAX}, unless otherwise noted. Typical values are at $T_A = +25°C$.) (Note 2)

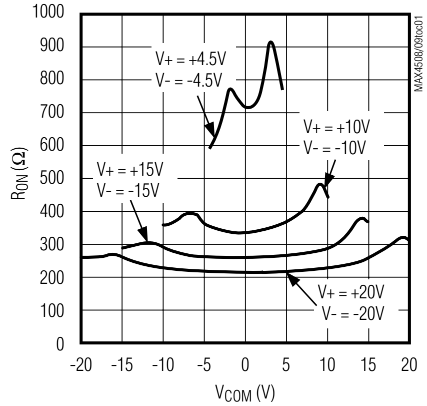
PARAMETER	SYMBOL	CONDITIONS	T_A	MIN	TYP	MAX	UNITS
SWITCH DYNAMIC CHARACTERISTICS							
Enable Turn-On Time	t_{ON}	$V_{COM_} = 10V$, $R_L = 2k\Omega$, Figure 3	+25°C		220	500	ns
			C, E, M			700	
Enable Turn-Off Time	t_{OFF}	$V_{COM_} = 10V$, $R_L = 2k\Omega$, Figure 3	+25°C		100	250	ns
			C, E, M			350	
Break-Before-Make Time Delay (Note 4)	t_{BBM}	$V_{COM_} = 10V$, $R_L = 2k\Omega$, Figure 4	+25°C	50	100		ns
Charge Injection (Note 4)	Q	$C_L = 1.0nF$, $V_{NO_} = 0$, $R_S = 0$, Figure 5	+25°C		2	10	pC
NO_ Off-Capacitance	$C_{NO_(OFF)}$	$V_{NO_} = 0$, f = 1MHz, Figure 8	+25°C		10		pF
COM_ Off-Capacitance	$C_{COM_(OFF)}$	$V_{COM_} = 0$, f = 1MHz, Figure 8	+25°C		19		pF
COM_ On-Capacitance	$C_{COM_(ON)}$	$V_{COM_} = V_{NO_} = 0$, f = 1MHz, Figure 8	+25°C		28		pF
Off-Isolation (Note 7)	V_{ISO}	$R_L = 75\Omega$, $C_L = 15pF$, $V_{NO_} = 1V_{RMS}$, f = 1MHz, Figure 6	+25°C		-70		dB
Channel-to-Channel Crosstalk (Note 8)	V_{CT}	$R_L = 75\Omega$, $C_L = 15pF$, $V_{NO_} = 1V_{RMS}$, f = 1MHz, Figure 7	+25°C		-62		dB
POWER SUPPLY							
Power-Supply Range	V+		C, E, M	9		36	V
V+ Supply Current	I+	All $V_{A_} = 0$ or 5V, $V_{NO_} = 0$, $V_{EN} = 5V$	+25°C		200	300	µA
			C, E, M			675	
		All $V_{A_} = 0$ or V+, $V_{NO_} = 0$, $V_{EN} = 0$ or V+	+25°C		100	250	
			C, E, M			375	

Note 2: The algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.
Note 3: NO_ pins are fault protected and COM_ pins are not fault protected. The max input voltage on NO_ pins depends on the COM_ load configuration. Generally, the max input voltage is ±36V with ±15V supplies and a load referred to ground. For more detailed information see the *NO_ Input Voltage* section.
Note 4: Guaranteed by design.
Note 5: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.
Note 6: Leakage parameters are 100% tested at the maximum rated hot temperature and guaranteed by correlation at $T_A = +25°C$.
Note 7: Off-Isolation = 20log10 ($V_{COM_}$ / $V_{NO_}$), where $V_{COM_}$ = output and $V_{NO_}$ = input to off switch.
Note 8: Between any two analog inputs.
Note 9: Leakage testing for single-supply operation is guaranteed by testing with dual supplies.
Note 10: Guaranteed by testing with dual supplies.

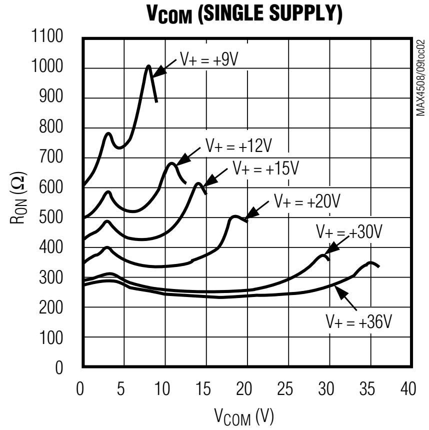
Typical Operating Characteristics

(V+ = +15V, V- = -15V, V_{EN} = +2.4V, T_A = +25°C, unless otherwise noted.)

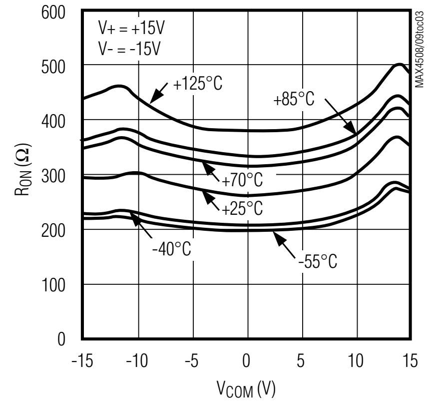
ON-RESISTANCE vs. V_{COM} (DUAL SUPPLIES)



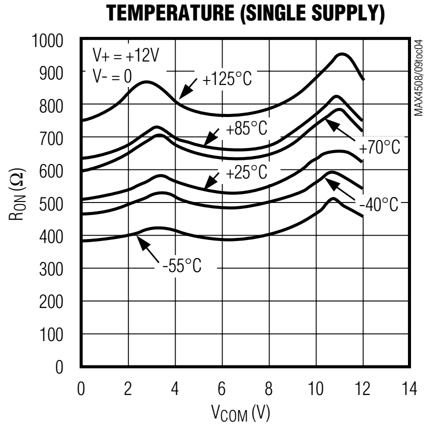
ON-RESISTANCE vs. V_{COM} (SINGLE SUPPLY)



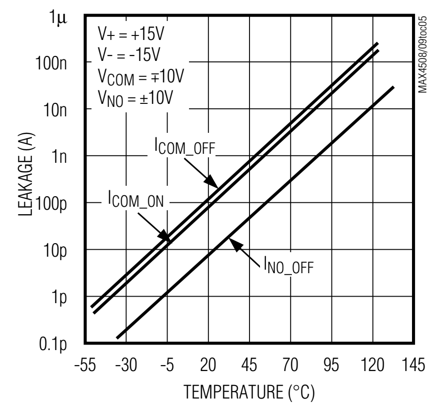
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (DUAL SUPPLIES)



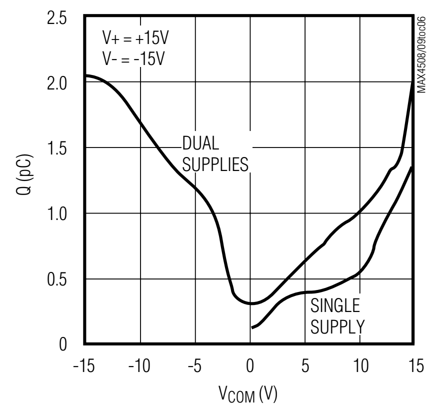
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (SINGLE SUPPLY)



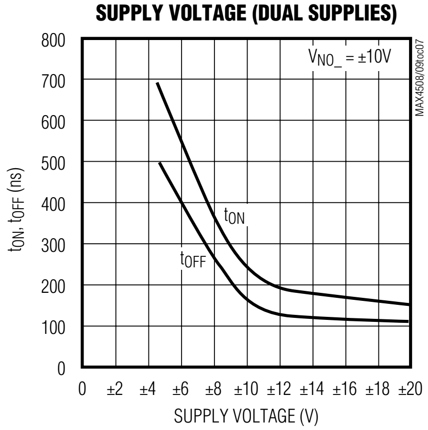
LEAKAGE CURRENT vs. TEMPERATURE



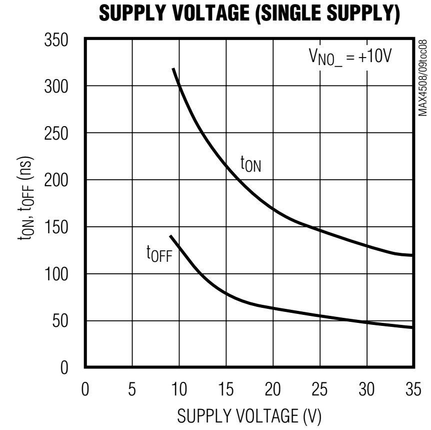
CHARGE INJECTION vs. V_{COM}



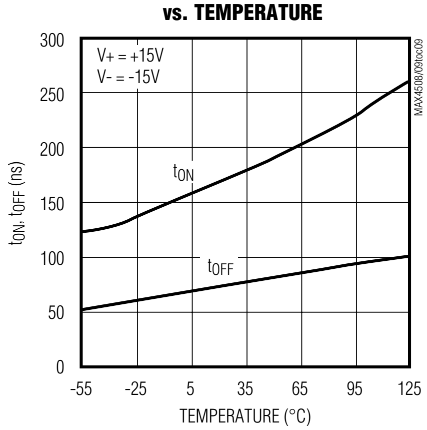
ENABLE ON AND OFF TIMES vs. SUPPLY VOLTAGE (DUAL SUPPLIES)



ENABLE ON AND OFF TIMES vs. SUPPLY VOLTAGE (SINGLE SUPPLY)



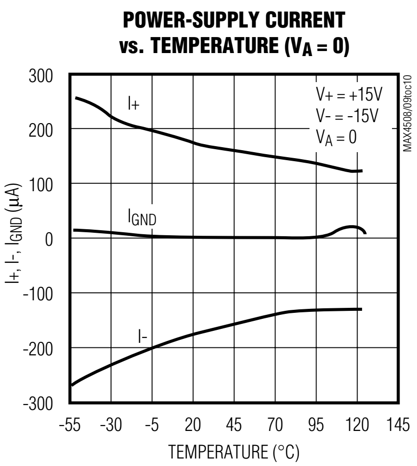
ENABLE ON AND OFF TIMES vs. TEMPERATURE

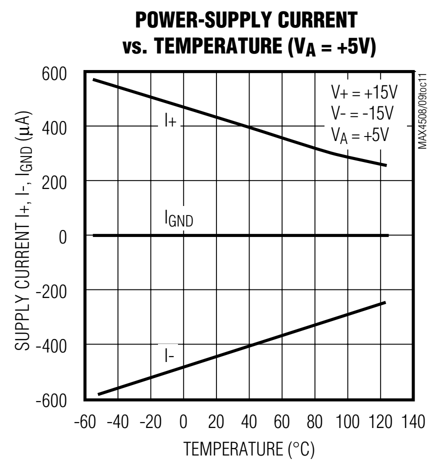


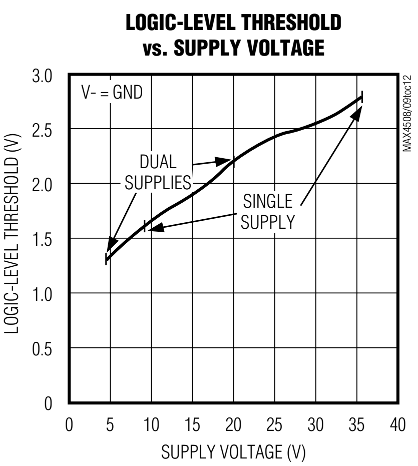
Fault-Protected, High-Voltage Single 8-to-1/ Dual 4-to-1 Multiplexers with Output Clamps

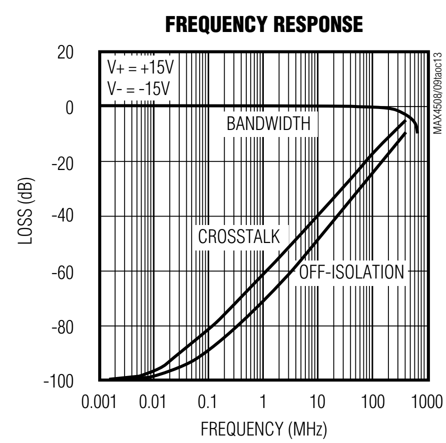
Typical Operating Characteristics (continued)

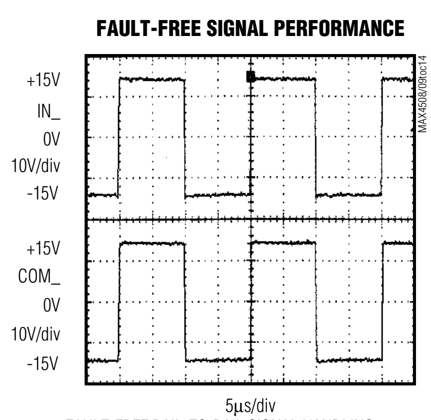
(V+ = +15V, V- = -15V, V_{EN} = +2.4V, T_A = +25°C, unless otherwise noted.)



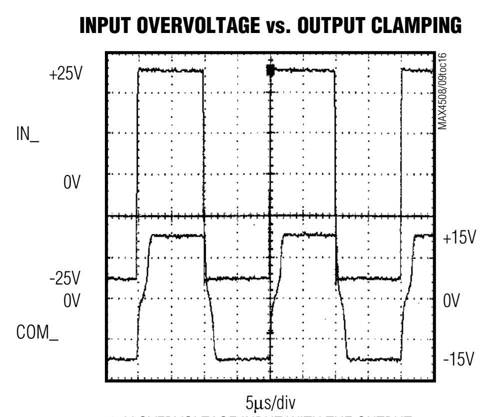








FAULT-FREE RAIL-TO-RAIL SIGNAL HANDLING WITH ±15V SUPPLIES



±25V OVERVOLTAGE INPUT WITH THE OUTPUT CLAMPED AT ±15V

Pin Descriptions

MAX4508 (Single 8-to-1 Mux)

PIN	NAME	FUNCTION
1	A0	Address Bit 0
2	EN	Mux Enable
3	V-	Negative Supply Voltage
4	NO1	Channel Input 1
5	NO2	Channel Input 2
6	NO3	Channel Input 3
7	NO4	Channel Input 4
8	COM	Analog Output
9	NO8	Channel Input 8
10	NO7	Channel Input 7
11	NO6	Channel Input 6
12	NO5	Channel Input 5
13	V+	Positive Supply Voltage
14	GND	Ground
15	A2	Address Bit 2
16	A1	Address Bit 1

MAX4509 (Dual 4-to-1 Mux)

PIN	NAME	FUNCTION
1	A0	Address Bit 0
2	EN	Mux Enable
3	V-	Negative Supply Voltage
4	NO1A	Channel Input 1A
5	NO2A	Channel Input 2A
6	NO3A	Channel Input 3A
7	NO4A	Channel Input 4A
8	COMA	Mux Output A
9	COMB	Mux Output B
10	NO4B	Channel Input 4B
11	NO3B	Channel Input 3B
12	NO2B	Channel Input 2B
13	NO1B	Channel Input 1B
14	V+	Positive Supply Voltage
15	GND	Ground
16	A1	Address Bit 1

Truth Tables

MAX4508 (Single 8-to-1 Mux)

A2	A1	A0	EN	ON SWITCH
x	x	x	0	None
0	0	0	1	NO1
0	0	1	1	NO2
0	1	0	1	NO3
0	1	1	1	NO4
1	0	0	1	NO5
1	0	1	1	NO6
1	1	0	1	NO7
1	1	1	1	NO8

MAX4509 (Dual 4-to-1 Mux)

A1	A0	EN	COMA	COMB
x	x	0	None	None
0	0	1	NO1A	NO1B
0	1	1	NO2A	NO2B
1	0	1	NO3A	NO3B
1	1	1	NO4A	NO4B

Detailed Description

Traditional fault-protected multiplexers are constructed with three series FET switches. This produces good off protection, but limits the switches input voltage range to as much as 3V below the supply rails, reducing its usable dynamic range. As the voltage on one side of the switch approaches within about 3V of either supply rail (a fault condition), the switch impedance increases, limiting the output signal range to approximately 3V less than the appropriate polarity supply voltage.

The MAX4508/MAX4509 differ considerably from traditional fault-protected multiplexers, offering several advantages. First, they are constructed with two parallel FETs, allowing very low resistance when the switch is on. Second, they allow signals on the NO_ pins that are within or beyond the supply rails to be passed through the switch to the COM terminal. This allows rail-to-rail signal operation. Third, when a signal $V_{NO_}$ exceeds the supply rails (i.e., a fault condition), the voltage on COM_ is limited to the supply rails. Operation is identical for both fault polarities.

Fault-Protected, High-Voltage Single 8-to-1/ Dual 4-to-1 Multiplexers with Output Clamps

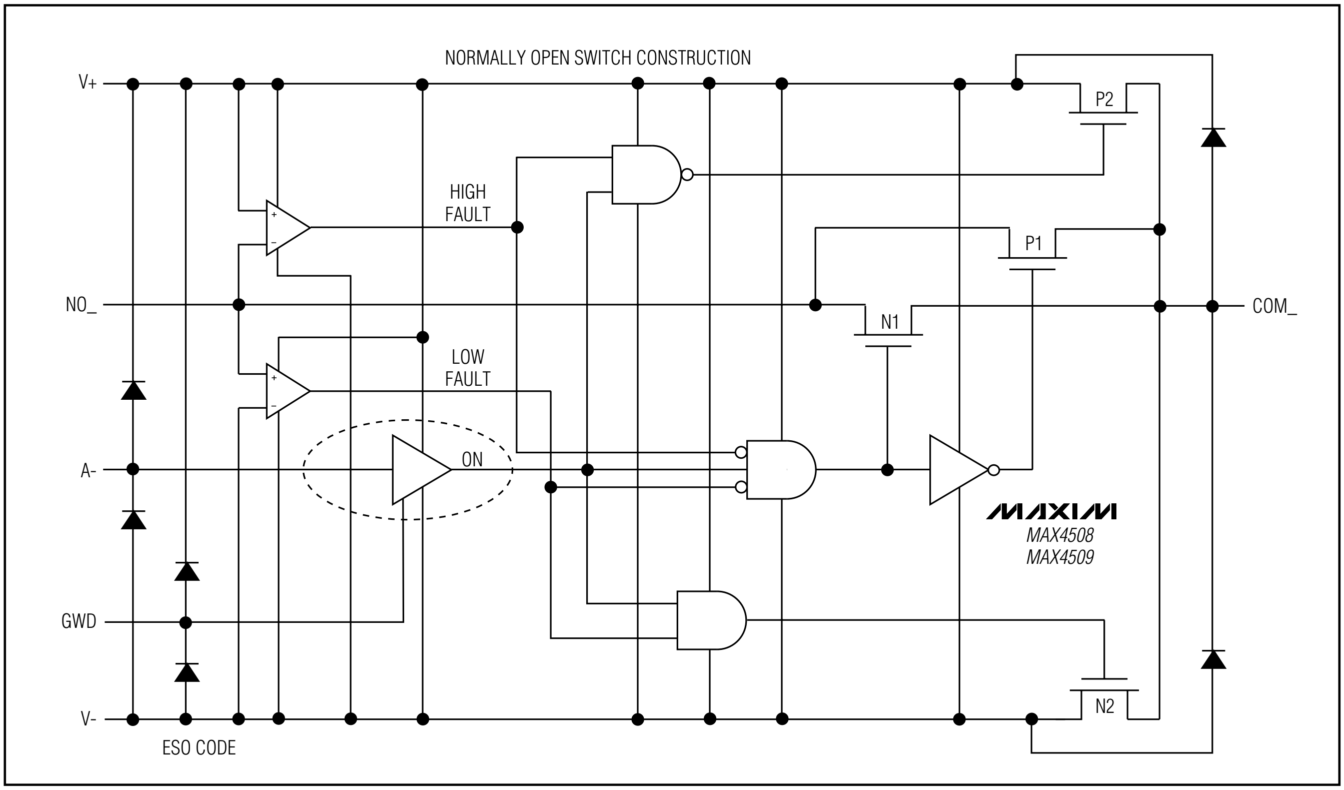


Figure 1. Functional Diagram

When the NO_ voltage goes beyond supply rails (fault condition), the NO_ input becomes high impedance regardless of the switch state or load resistance. When power is removed, and the fault protection is still in effect, the NO_ terminals are a virtual open circuit. The fault can be up to ±40V, with V+ = V- = 0. If the switch is on, the COM_ output current is furnished from the V+ or V- pin by "booster" FETs connected to each supply pin. These FETs can source or sink up to 10mA.

The COM_ pins are not fault protected. If a voltage source is connected to any COM_ pin, it should be limited to the supply voltages. Exceeding the supply voltage will cause high currents to flow through the ESD protection diodes, damaging the device (see *Absolute Maximum Ratings*).

Figure 1 shows the internal construction, with the analog signal paths shown in bold. A single normally open (NO) switch is shown. The analog switch is formed by the parallel combination of N-channel FET N1 and P-channel FET P1, which are driven on and off simultaneously, according to the input fault condition and the logic level state.

NO_ Input Voltage

The maximum allowable input voltage for safe operation depends on whether supplies are on or off and the load configuration at the COM output. If COM is referred to a voltage other than ground, but within the supplies, $V_{NO_}$ may range higher or lower than the supplies provided the absolute value of $|V_{NO_} - V_{COM_}|$ is less than 40V. For example, if the load is referred to +10V at COM_, then the NO_ voltage range can be from +50V to -30V. As another example, if the load is connected to -10V at COM_, the NO_ voltage range is limited to -50V to +30V.

If the supplies are ±15V and COM is referenced to ground through a load, the maximum NO_ voltage is ±25V. If the supplies are off and the COM output is referenced to ground, the maximum NO_ voltage is ±40V.

Normal Operation

Two comparators continuously compare the voltage on the NO_ pin with V+ and V- supply voltages. When the signal on NO_ is between V+ and V-, the multiplexer behaves normally, with FETs N1 and P1 turning on and off in response to A_ signals (Figure 1). The parallel

combination of N1 and P1 forms a low-value resistor between NO_ and COM_ so that signals pass equally well in either direction.

Positive Fault Condition

When the signal on NO_ exceeds V+ by about 150mV, the positive fault comparator output goes high, turning off FETs N1 and P1 (Figure 1). This makes the NO_ pin high impedance, regardless of the switch state. If the switch state is "off," all FETs turn off, and both NO_ and COM_ are high impedance. If the switch state is "on," FET P2 turns on, clamping COM_ to V+.

Negative Fault Condition

When the signal on NO_ goes about 150mV below V-, the negative fault comparator output goes high, turning off FETs N1 and P1 (Figure 1). This makes the NO_ pin high impedance, regardless of the switch state. If the switch state is "off," all FETs turn off, and both NO_ and COM_ are high impedance. If the switch state is "on," FET N2 turns on, clamping COM_ to V-.

Transient Fault Condition

When a fast rising or falling transient on NO_ exceeds V+ or V-, the output (COM_) follows the input (NO_) to the supply rail with only a few nanoseconds delay. This delay is due to the switch on-resistance and circuit capacitance to ground. When the input transient returns to within the supply rails, however, there is a longer output recovery time. For positive faults, the recovery time is typically 2.5µs (see *Typical Operating Characteristics*). For negative faults, the recovery time is typically 1.3µs. These values depend on the COM_ output resistance and capacitance. The delays do not depend on the fault amplitude. Higher COM_ output resistance and capacitance increase the recovery times.

COM and A_

FETs N2 and P2 can source about ±10mA from V+ or V- to the COM_ pin in the fault condition (Figure 1). Ensure that if the COM_ pin is connected to a low-impedance load, the absolute maximum current rating of 30mA is never exceeded, either in normal or fault conditions.

The GND, COM_, and A_ pins do not have fault protection. Reverse ESD protection diodes are internally connected between GND, COM_, A_, and both V+ and V-. If a signal on GND, COM_, or A_ exceeds V+ or V- by more than 300mV, one of these diodes will conduct. During normal operation, these reverse-biased ESD diodes leak a few nanoamps of current to V+ and V-

Fault Protection Voltage and Power Off

The maximum fault voltage on the NO_ pins is ±40V from ground when the power is off. With ±15V supply voltages, the highest voltage on NO_ can be V- + 40V, and the lowest voltage on NO can be V+ - 40V. Exceeding these limits can damage the chip.

Logic Level Thresholds

The logic level thresholds are CMOS and TTL compatible with V+ = 13.5V to V+ = 16.5V.

Applications Information

Ground

There is no connection between the analog signal paths and GND. The analog signal paths consist of an N-channel and a P-channel MOSFET with their sources and drains paralleled and their gates driven out of phase to V+ and V- by the logic-level translators.

V+ and GND power the internal logic and logic level translators and set the input logic thresholds. The logic-level translators convert the logic levels to switched V+ and V- signals to drive the gates of the multiplexers. This drive signal is the only connection between the power supplies and the analog signals. GND, A_, and COM_ have ESD protection diodes to V+ and V-.

Supply Current Reduction

When the logic signals are driven rail-to-rail from 0 to +15V or -15V to +15V, the current consumption will be reduced from 370µA (typ) to 200µA.

Power Supplies

The MAX4508/MAX4509 operate with bipolar supplies between ±4.5V and ±20V. The V+ and V- supplies need not be symmetrical, but their sum cannot exceed the 44V absolute maximum rating.

The MAX4508/MAX4509 operate from single supplies between +9V and +36V when V- is connected to GND.

Fault-Protected, High-Voltage Single 8-to-1/ Dual 4-to-1 Multiplexers with Output Clamps

Test Circuits/Timing Diagrams

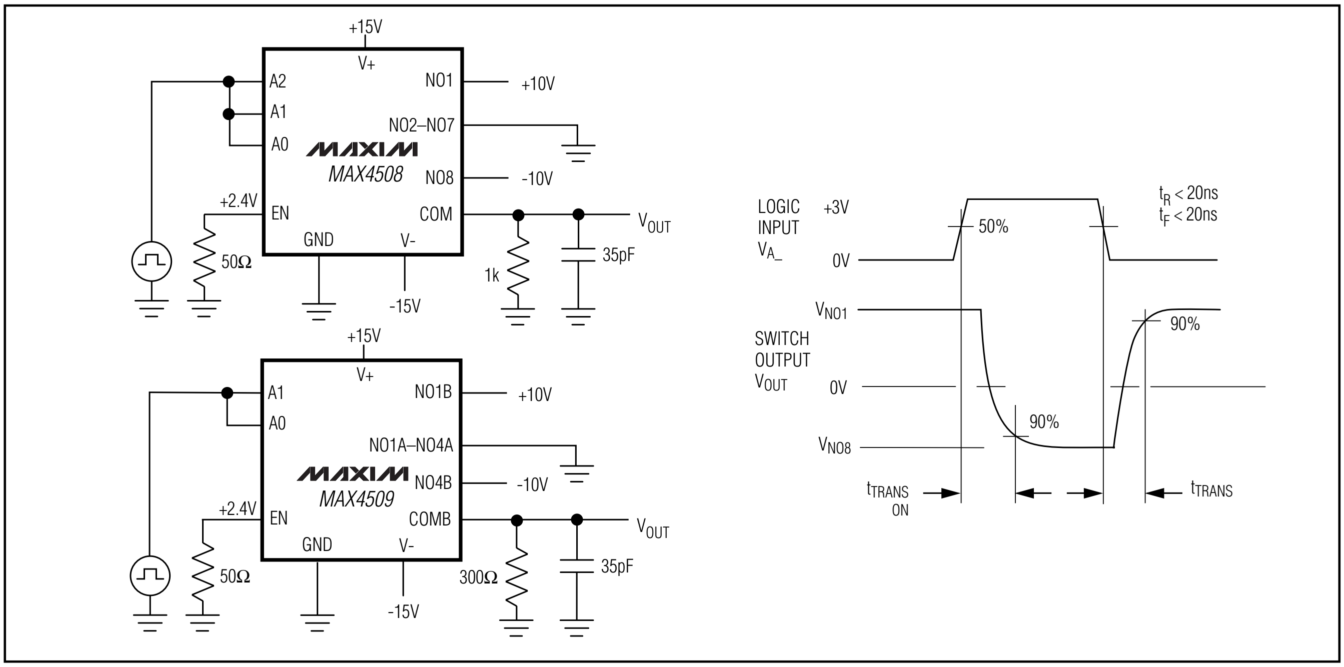


Figure 2. Address Transition Time

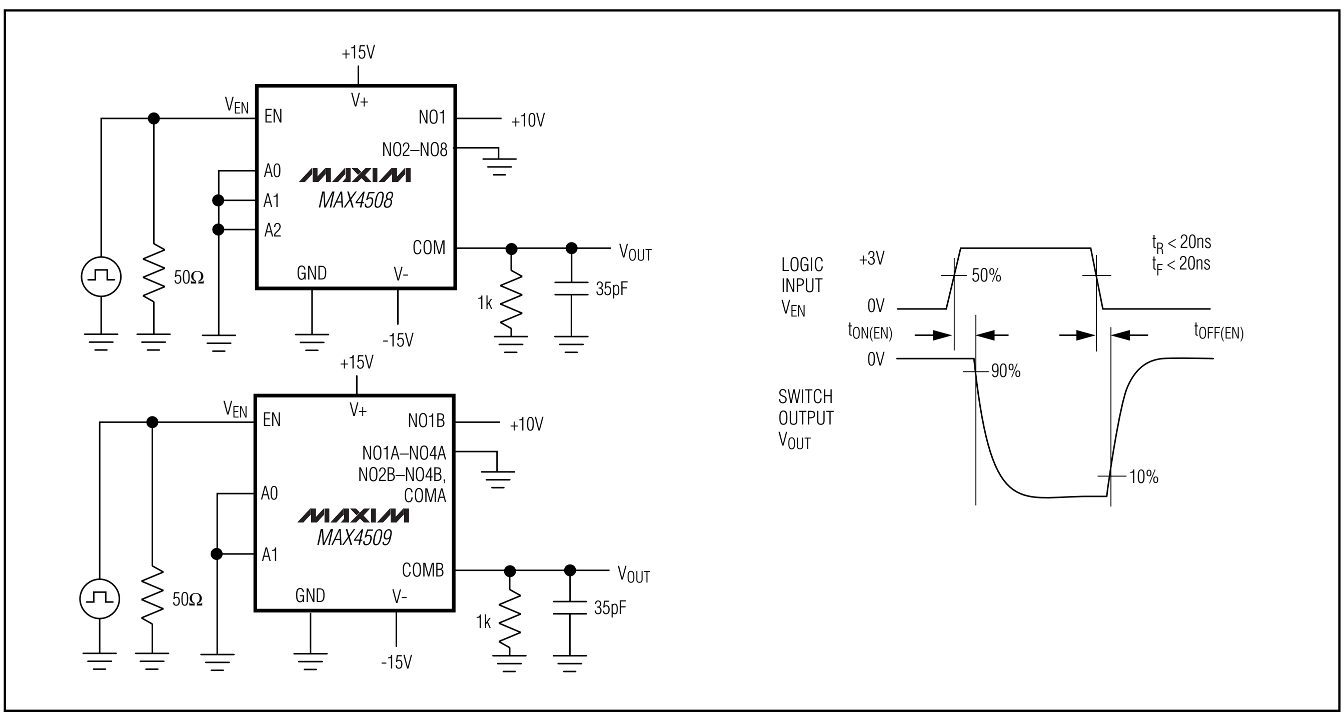


Figure 3. Enable Switching Time

Test Circuits/Timing Diagrams (continued)

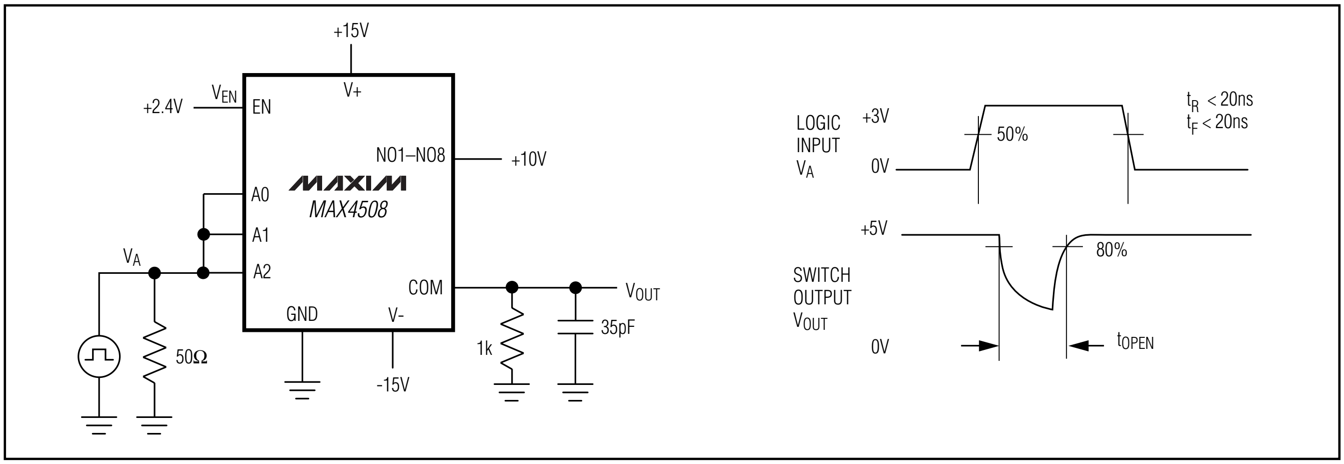


Figure 4. MAX4508 Break-Before-Make Interval

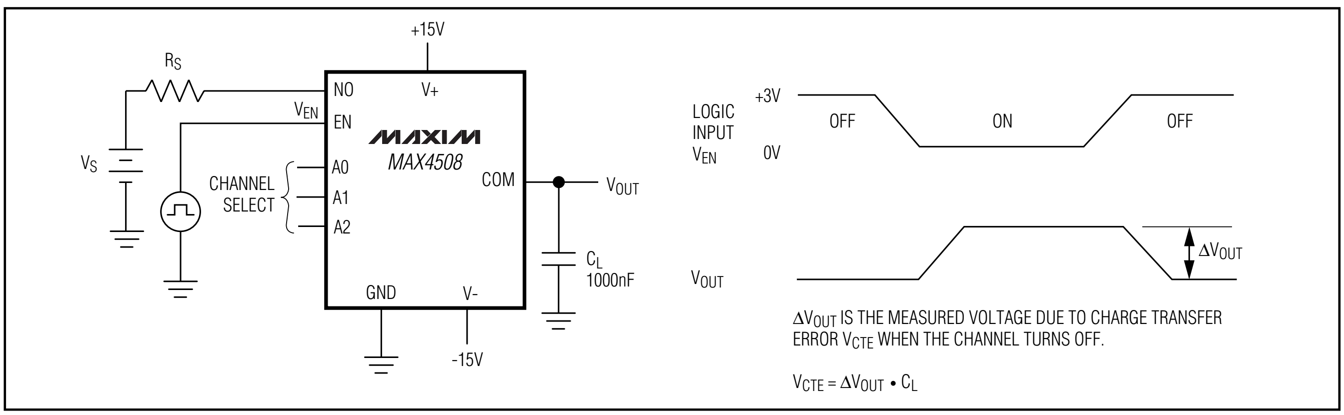


Figure 5. Charge Injection

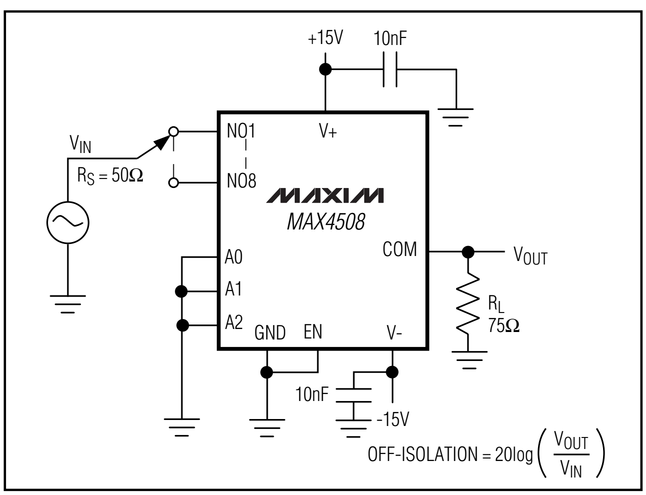


Figure 6. Off-Isolation

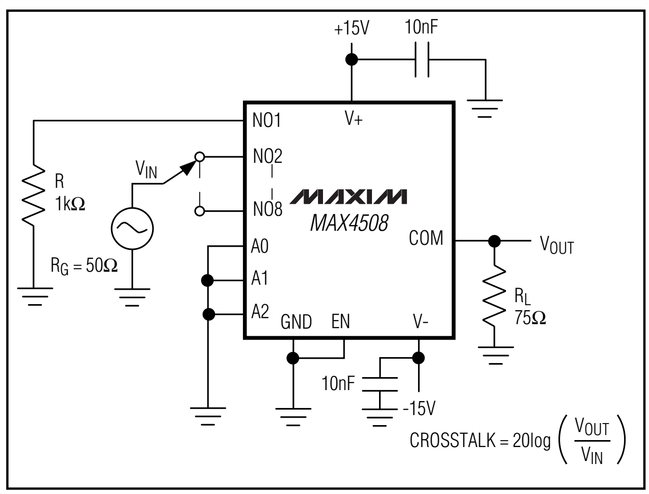


Figure 7. Crosstalk

Fault-Protected, High-Voltage Single 8-to-1/ Dual 4-to-1 Multiplexers with Output Clamps

Test Circuits/Timing Diagrams (continued)

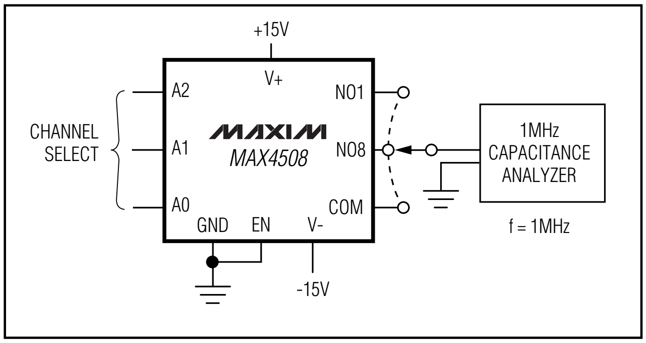


Figure 8. NO_, COM_ Capacitance

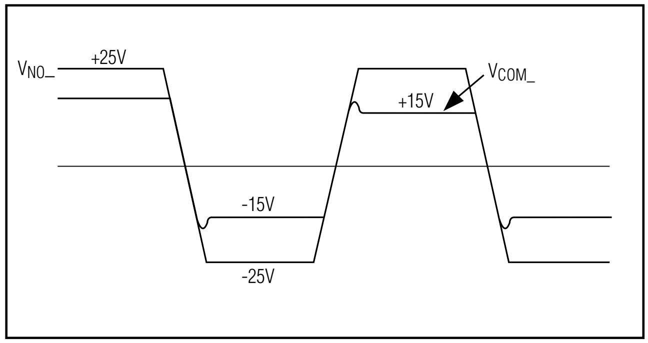
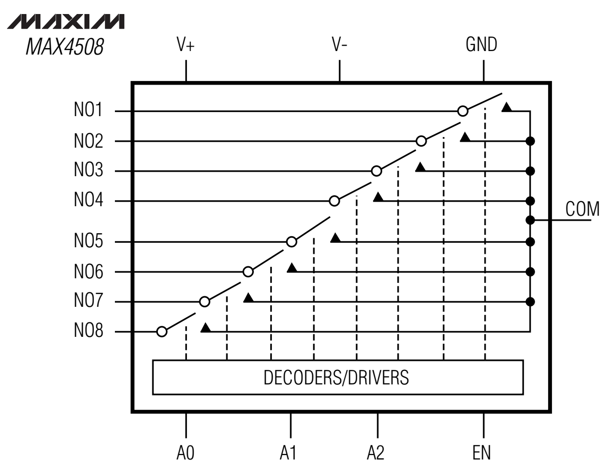


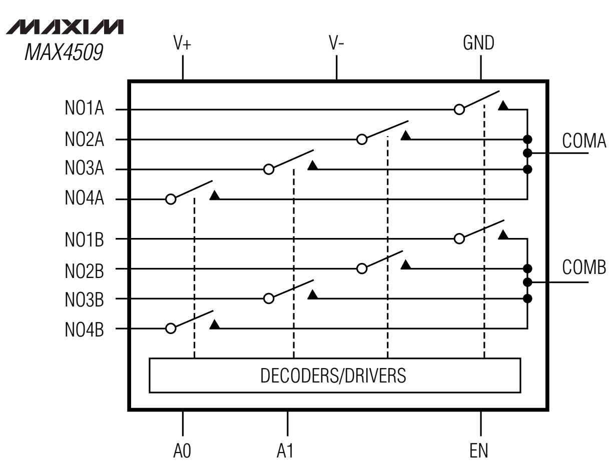
Figure 9. Transient Behavior of Fault Condition

Functional Diagrams/Truth Tables



MAX4508				
A2	**A1**	**A0**	**EN**	**ON SWITCH**
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

LOGIC "0" $V_{AL} \leq +0.8V$, LOGIC "1" $V_{AH} \geq +2.4V$



MAX4509			
A1	**A0**	**EN**	**ON SWITCH**
X	X	0	NONE
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

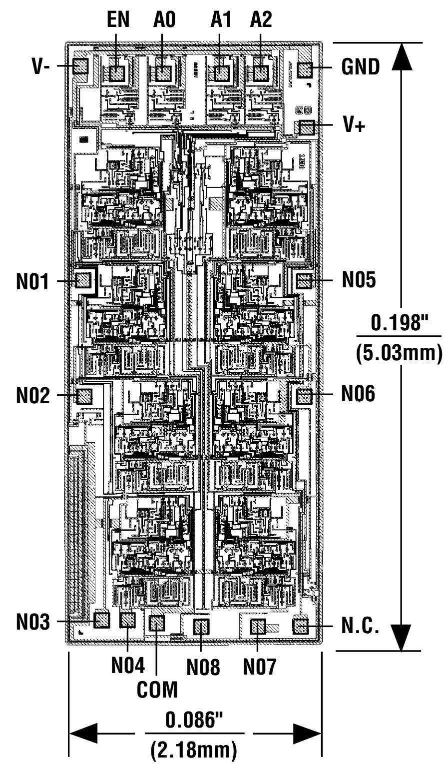
LOGIC "0" $V_{AL} \leq +0.8V$, LOGIC "1" $V_{AH} \geq +2.4V$

Ordering Information (continued)

PART	TEMP RANGE	PIN-PACKAGE	PKG CODE
MAX4509CSE+	0°C to +70°C	16 Narrow SO	S16-8
MAX4509CPE+	0°C to +70°C	16 Plastic DIP	P16-4
MAX4509C/D	0°C to +70°C	Dice*	—
MAX4509ESE+	-40°C to +85°C	16 Narrow SO	S16-8
MAX4509EPE+	-40°C to +85°C	16 Plastic DIP	P16-4
MAX4509MJE	-40°C to +85°C	16 CERDIP**	J16-3

*Contact factory for dice specifications.
**Contact factory for availability.
+Denotes a lead-free package.

Chip Topography

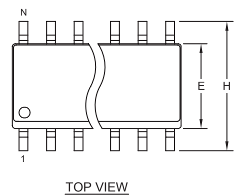


SUBSTRATE IS INTERNALLY CONNECTED TO V+

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

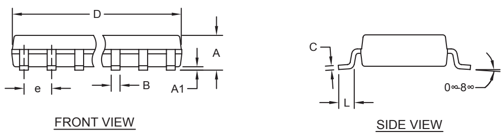
SOICN .EPS



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.053	0.069	1.35	1.75
A1	0.004	0.010	0.10	0.25
B	0.014	0.019	0.35	0.49
C	0.007	0.010	0.19	0.25
e	0.050 BSC		1.27 BSC	
E	0.150	0.157	3.80	4.00
H	0.228	0.244	5.80	6.20
L	0.016	0.050	0.40	1.27

VARIATIONS:

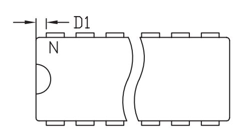
	INCHES		MILLIMETERS			
DIM	MIN	MAX	MIN	MAX	N	MS012
D	0.189	0.197	4.80	5.00	8	AA
D	0.337	0.344	8.55	8.75	14	AB
D	0.386	0.394	9.80	10.00	16	AC

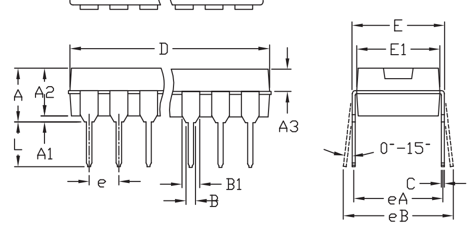


NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
4. CONTROLLING DIMENSION: MILLIMETERS.
5. MEETS JEDEC MS012.
6. N = NUMBER OF PINS.

DALLAS SEMICONDUCTOR MAXIM
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, .150" SOIC
APPROVAL | DOCUMENT CONTROL NO. 21-0041 | REV. B | 1/1

PDIPN.EPS





	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	---	0.180	---	4.572
A1	0.015	---	0.38	---
A2	0.125	0.175	3.18	4.45
A3	0.055	0.080	1.40	2.03
B	0.015	0.022	0.381	0.56
B1	0.045	0.065	1.14	1.65
C	0.008	0.014	0.2	0.355
D1	0.005	0.080	0.13	2.03
E	0.300	0.325	7.62	8.26
E1	0.240	0.310	6.10	7.87
e	0.100 BSC.		2.54 BSC.	
eA	0.300 BSC.		7.62 BSC.	
eB	0.400 BSC.		10.16 BSC.	
L	0.115	0.150	2.921	3.81

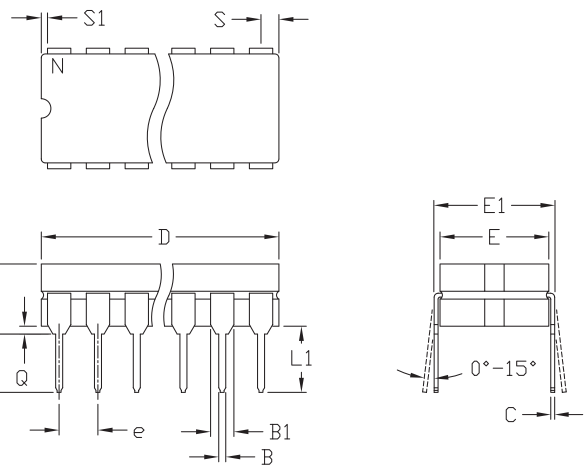
	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	MS001
D	0.348	0.390	8.84	9.91	8	AB
D	0.735	0.765	18.67	19.43	14	AC
D	0.745	0.765	18.92	19.43	16	AA
D	0.885	0.915	22.48	23.24	18	AD
D	1.015	1.045	25.78	26.54	20	AE
D	1.14	1.265	28.96	32.13	24	AF
D	1.360	1.380	34.54	35.05	28	*5

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER
4. MEETS JEDEC MS001-XX AS SHOWN IN ABOVE TABLE
5. SIMILIAR TO JEDEC MO-058AB
6. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR. SUNNYVALE CA 94086 FAX (408) 737 7194
PROPRIETARY INFORMATION
PACKAGE FAMILY OUTLINE: PDIP .300" | TITLE | 1/1 | 21-0043 D | DOCUMENT CONTROL NUMBER | REV

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)



	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	---	0.200	---	5.08
B	0.014	0.023	0.36	0.58
B1	0.038	0.065	0.97	1.65
C	0.008	0.015	0.20	0.38
E	0.220	0.310	5.59	7.87
E1	0.290	0.320	7.37	8.13
e	0.100		2.54	
L	0.125	0.200	3.18	5.08
L1	0.150	---	0.00	---
Q	0.015	0.070	0.38	1.78
S	---	0.098	---	2.49
S1	0.005	---	0.13	---

	INCHES		MILLIMETERS			
	MIN	MAX	MIN	MAX	N	CASE
D	---	0.405	---	10.29	8	P:D4
D	---	0.785	---	19.94	14	C:D1
D	---	0.840	---	21.34	16	E:D2
D	---	0.960	---	24.38	18	V:D6
D	---	1.060	---	26.92	20	R:D8
D	---	1.280	---	32.51	24	L:D9

NOTES:
1. CONTROLLING DIMENSION: INCH
2. MEETS 1835 CASE OUTLINE CONFIGURATION #1 AS SHOWN IN ABOVE TABLE
3. N = NUMBER OF PINS

MAXIM 120 SAN GABRIEL DR. SUNNYVALE CA 94086 FAX (408) 737 7194
PROPRIETARY INFORMATION

TITLE: PACKAGE FAMILY OUTLINE: CDIP .300"

1/1

DOCUMENT CONTROL NUMBER: 21-0045 REV: A

Fault-Protected, High-Voltage Single 8-to-1/ Dual 4-to-1 Multiplexers with Output Clamps

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
5	10/07	EC table changes and stylistic corrections	2–5